-5-

DEVELOPMENT OF AN ALTITUDE DECOMPRESSION SICKNESS MODEL. T.E. Scoggins*, E.P. Ripley[1], D.H. Bauer, and A.A. Pilmanis*. Armstrong Laboratory, Brooks AFB TX 78235-5000 and [1]KRUG Life Sciences, San Antonio TX.

INTRODUCTION. Availability of a computer model which could accurately predict the risk of altitude decompression sickness (DCS) for any given hypobaric exposure would be a great improvement over current risk assessment methods based on comparison of the planned mission profile with data from previous, often dissimilar exposures. METHODS. Equations for perfusion-limited inert gas exchange and bubble growth were used to compute tissue ratio (TR) and bubble volume data for 12 exposure profiles between 9,000 and 30,000 ft for which experimental DCS incidence data from 395 subjects had been previously collected. Three parameters, TR, maximum bubble volume (Vm) and bubble volume at onset of DCS (Vo), were linked with observed DCS incidence using the Hill equation with coefficients determined by non-linear regression analysis. RESULTS. The TR and Vm models both predicted no DCS correctly in 96% of the cases while the Vo model correctly predicted 80%. The postive predictive capabilities were lower with the TR and Vm models predicting 74% and the Vo model predicting 67% of the DCS cases correctly. CONCLUSIONS. This approach shows promise as an objective computer-based method for predicting altitude DCS risk. Refinement of the algorithms based on additional experimental data should improve the validity of the models.

-6-

USE OF ECHO IMAGING IN DECOMPRESSION MODEL DEVELOPMENT. R.M. Olson*, A.A. Pilmanis*, and T.E. Scoggins*. KRUG Life Sciences, San Antonio, TX 78279-0644 and Brooks Air Force Base, TX 78235-5000.

**INTRODUCTION.** A model which assesses the risk of decompression sickness (DCS) associated with altitude exposures of various profiles is needed. This paper describes how echo imaging techniques can provide critical measurements, such as bubble size, to support the development of a decompression model. **METHODS.** Three healthy male subjects were exposed to a simulated altitude of 29,500 ft. They were monitored with the Hewlett Packard SONOS 1000 echo imaging system at two monitoring sites, the heart and the inferior vena cava (IVC) as viewed through the liver. Consequently, the hepatic veins and bile duct system were also observed. **RESULTS.** Bubble size was found to be between 5 and 100 micra both in the IVC and in the hepatic veins. The upper size limit was established by IVC microbubble flotation rates. Size confirmation was provided by observation of pressure-induced right ventricular bubble resolution. Microbubbles were visualized in the gall bladder and hepatic veins but not in the liver itself. Therefore hepatic tissue bubbles, if they exist, are smaller than intravascular bubbles. This size range was incorporated into the ongoing development of a decompression model. **CONCLUSIONS.** Echo imaging is a powerful tool for DCS research and model development.

110323

**N95-16738**

-7-

THE EFFECT OF DIFFERENCES IN TIME TO DETECTION OF CIRCULATING MICROBUBBLES ON THE RISK OF DECOMPRESSION SICKNESS. K.V. Kumar*, J.H. Gilbert*, M.R. Powell, and J.M. Waligora. KRUG Life Sciences*, and NASA Johnson Space Center, Houston, TX 77058.

INTRODUCTION. Circulating microbubbles (CMB) are frequently detected prior to the appearance of symptoms of Decompression Sickness (DCS). It is difficult to analyze the effect of CMB on symptoms due to differences in the time to detection of CMB. This paper uses survival analysis models to evaluate the risk of symptoms in the presence of CMB. METHODS. Information on 81 exposures to an altitude of 6,400 m (6.5 psi) for a period of three hours, with simulated extravehicular activities, was examined. The presence or absence of CMB was included as a time-dependent covariate in the Cox proportional hazards regression model. Using this technique, the subgroup of exposures with CMB was analyzed further. RESULTS. Mean (S.D.) times in minutes to onset of CMB and symptoms were 125 (63) and 165 (33), respectively, following the three-hour exposures. The risk of symptoms (17/81) increased 14 times in the presence of CMB, after controlling for variations in time to detection of CMB. Further, the risk was lower when time to detection of CMB was >60 minutes (risk ratio=0.96; 95% confidence intervals=0.94-0.99; P<0.01), compared to CMB detected before 60 minutes at altitude. CONCLUSIONS. Survival analysis showed that individual risk of DCS changes significantly due to variations in time to detection of CMB. This information is important in evaluating the risk of DCS in the presence of CMB.

-8-

**INTRAVENOUS PERFLUOROCARBON EMULSION VS. HYPERBARIC OXYGEN IN THE TREATMENT OF ACUTE DECOMPRESSION SICKNESS.**
J. Simanonok.* Wright State University School of Medicine.
J. Mulcare and A. Woodrow. Wright Patterson AFB, Dayton, OH.

INTRODUCTION: Treatment of decompression sickness (DCS) with hyperbaric oxygen (HBO) uses the physical rationale of decreased bubble size and increased bubble-to-tissue nitrogen gradient with recompression and oxygen breathing. Intravenous perfluorocarbon emulsions (PFC) are proposed as an alternate treatment, using the physical rationale of increased nitrogen solubility in the dissolving fluid. Previous studies have shown an efficacy of PFC in DCS treatment, but none have compared such treatment with HBO. METHODS: We subjected male Wistar rats to an insult dive (200 fsw x 75 min, 6 min ascent) followed by treatment with either intravenous normal saline (35 ml/kg) and the Air Force hyperbaric treatment table 6, or intravenous Fluosol (35 ml/kg) and 100% oxygen at 1 ATA. We noted mortality and open field behavioral indices (Opto-Varimex, Columbus Instruments). RESULTS: Mortality was equal in both treatment groups (HBO: 47%, n = 43; PFC: 36%, n = 39), though similar to that observed in untreated animals in a pilot study. Open field monitoring showed no differences in distance travelled, time resting or ambulatory, and number of small movements, though PFC-treated rats spent less time in "stereotypic" movements. CONCLUSIONS: Although interpretation is limited by technical difficulties, the efficacies of intravenous perfluorocarbon emulsion and hyperbaric oxygen were comparable. A more concentrated fluorocarbon preparation may be more effective, since it would decrease the fluid volume required to achieve a given fluorocrit.

-9-

**DECOMPRESSION SICKNESS PROTECTION USING A 100% OXYGEN PRESSURE SUIT ENVIRONMENT.** J. T. Webb*, KRUG Life Sciences, San Antonio, TX 78279-0644 and A. A. Pilmanis*, AL/CFTS, Brooks AFB, TX 78235-5000.

**INTRODUCTION.** Selection of the lowest safe pressure for an extravehicular activity (EVA) suit which eliminates the requirement for prebreathing depends on demonstrating an acceptable risk of venous gas emboli (VGE; precordial Doppler grades 3 and 4) and decompression sickness (DCS). The EVA suit target pressure of 8.3 psia was set by NASA several years ago based on results of breathing 50% oxygen and 50% nitrogen during zero-prebreathe exposures. The present work investigated the effects of zero-prebreathe exposures at and below 8.3 psia while breathing 100% oxygen. **METHODS.** Thirty male human subjects were exposed for 6 hours, without prebreathing, to pressures of 8.3 (n=10), 7.8 (n=10), and 7.3 (n=10) psia while performing moderate exercise. Subjects were monitored for Doppler-detected VGE using Hewlett-Packard SONOS systems and observed for DCS symptoms. **RESULTS.** No cases of DCS were present at 8.3, 7.8, or 7.3 psia. Grade 3 or 4 VGE were not detected at 8.3 psia but were present during 10% and 20% of the exposures at 7.8 and 7.3 psia respectively. **CONCLUSION.** EVA suit pressure with a 100% oxygen environment could be established at 7.3 psia and maintain lower DCS and VGE risk levels compared to an 8.3 psia suit pressure with a 50% oxygen:50% nitrogen environment.

**N95-16739**

-10-

110324

VARIABILITY IN HOFFMANN AND TENDON REFLEXES IN HEALTHY MALE SUBJECTS. E. Good, S. Do, and M. Jaweed*. Humana Hospital, Webster, TX; Baylor College of Medicine, Houston, TX; and *NASA Johnson Space Center, Biomedical Operations & Research Branch, Houston, TX 77058.

INTRODUCTION: There is a time dependent decrease in amplitude of H- and T-reflexes during O-G exposure and subsequently an increase in the amplitude of the H-reflex 2-4 hrs after return to 1-G environment. These alterations have been attributed to adaptation of the human neurosensory system to gravity. The Hoffmann reflex (H-reflex) is an acknowledged method to determine the integrity of the monosynaptic reflex arc. However, deep tendon reflexes (DTR's or T-reflexes), elicited by striking the tendon also utilizes the entire reflex arc. The objective of this study was to compare the variability in latency and amplitude of the two reflexes in healthy subjects. METHODS: Nine healthy male subjects, 27-43 years in age, 161-175 cm in height plus 60-86 Kg in weight, underwent weekly testing for four weeks with a Dan-Tec EMG counterpoint EMG system (Dan Tec, Inc., Denmark). Subjects were studied prone and surface EMG electrodes were placed on the right and left soleus muscles. The H-reflex was obtained by stimulating the tibial nerve in the politeal fossa with a 0.2 msec square wave pulses delivered at 2 Hz until the maximum H-reflex was obtained. The T-reflex was evoked by tapping the achilles tendon with a self-triggering reflex hammer connected to the EMG system. The latencies and amplitudes for the H- and T-reflexes were measured. RESULTS: These data indicate that the amplitudes of these reflexes varied considerably. However, latencies to evoked responses were consistent. The latency of the T-reflex was approximately 3-5 msec longer than the H-reflex. CONCLUSION: The T-reflex is easily obtained, requires less time, and is more comfortable to perform. Quantitative data can be obtained by deploying self-triggering, force plated reflex hammer both in the 1-G and O-G environment.

-11-

**POSTURAL EQUILIBRIUM TESTING OF AVIATORS: NORMATIVE SCORES AND ADAPTATION EFFECTS.** K.A.Baylor*[1], B.J. McGrath*[1], S.M. Molstad[2], A.H. Rupert*[1], and F.E. Guedry*[3]. [1]Naval Aerospace Medical Research Laboratory, Pensacola, FL; [2]Northwestern State University, Natchitoches, LA; and [3]University of West Florida, Pensacola, FL.

INTRODUCTION. An estimated 29% of aviators experience symptoms of Simulator Sickness (SS) following simulator training. Highly sensitive measures are required to assess the aftereffects of simulator training on balance and coordination, and the impact on performance and safety. The Neurocom Equitest System is a clinical device that examines the interaction of vestibular, visual and proprioceptive inputs on the balancing ability of subjects. The purposes of this study were to develop a normative aviator database as compared to clinical norms, and to determine learning effects from repeated test sessions. METHODS. Fifty-three male and 33 female aviators were tested on an initial day using an Equitest System. Repeat testing was completed on 19 males and 11 females on four additional days. RESULTS. Sensory Organization Test (SOT) equilibrium scores for the aviators were significantly higher than clinical norms. Equilibrium scores on the first trial were significantly lower than on the two subsequent trials. Differences between males and females existed in a correlation between equilibrium and strategy scores. A significant learning effect existed for equilibrium, with a plateau reached after 3 days. Motor Coordination Test latency scores for male aviators were significantly faster than for females. CONCLUSIONS. The high aviator scores demonstrate the importance of establishing population-specific norms for balance research. Gender differences among the aviators on latency scores support previous research establishing similar differences in reaction time. The learning effects from repeated SOT tests, which reduce the effectiveness of this device to assess SS aftereffects in pre- and post-simulator testing, may be minimized with random-order trials.



-12-

THE PSYCHOPHYSICAL FUNCTION FOR PERCEIVED GRAVITATIONAL-INERTIAL FORCE DOES NOT DEPEND ON THE ORIENTATION OF THE OTOLITH ORGANS. M. Cohen,* R. Welch,* and C. DeRoshia*. NASA-Ames Research Center, Moffett Field, CA 94035.

INTRODUCTION. It has generally been believed that the perceived intensity of a gravitational-inertial force depends on both the magnitude and orientation of the force with respect to the otolith organs, as does the elevator illusion. In this study, we examine the perceived intensity of Gz force and the elevator illusion as a function of the applied force and the orientation of S's head. METHODS. Each of eleven male Ss was seated upright in a swinging chair mounted in the Ames 20-G Human Centrifuge while he set a visual target to his apparent horizon and judged the perceived intensity of Gz forces by cross-modal matches on a hand dynamometer. Plateau Gz levels were 1.00, 1.25, 1.50, 2.00, 2.25, and 2.50; a 30-second ramp to plateau was used in all cases, and the duration of exposure at each plateau was 120 seconds. All measures were obtained both with S's head erect and pitched forward 30 degrees. RESULTS. Although the elevator illusion changed with head orientation ($F(6,60) = 7.56$; $p<0.001$), the perceived intensity of Gz was essentially the same for both orientations of the head ($F(6,60) = 0.61$; $p>.50$). CONCLUSIONS. The results of this experiment suggest that the perceived intensity of gravitational-inertial force does not depend on otolith mechanisms in the same way as does the elevator illusion and that somesthetic, tactile, and other proprioceptive inputs are important for the psychophysical function.



-13-

USE OF INJECTABLE PROMETHAZINE TO DECREASE SYMPTOM SCORES OF SPACE MOTION SICKNESS. B.G. BECK, M.D.* A.E. NICOGOSSIAN, M.D.* MEDICAL OPERATIONS BRANCH, NASA-JSC, HOUSTON, TX 77058

**Introduction**. Space Motion Sickness (SMS) has been a problem affecting approximately 74% of first-time Shuttle flyers. Promethazine injections have been used for 29 cases of SMS to decrease the severity of their illness. Although reported to be effective in reducing symptoms in 27 of the 29 cases, there has been no proof of its efficacy. **Methods**. Retrospective analyses of Medical Debriefs examining the symptom scores for nausea, vomiting, decreased appetite, and stomach awareness were performed. Each symptom is rated on a mild=1, moderate=2, severe=3 system for each flight day. Crewmember scores from the first three flight days on an initial flight in which injectable promethazine had not been used were compared to scores in a later flight in which the promethazine was utilized. Scores were also compared in a similar group of crewmembers who did not use promethazine. **Results**. There was a decrease in median scores for all symptoms except nausea, however it was significant ($p=.014$) only for the vomiting scores. This significant decrease was not seen in the control group. **Conclusions**. Injectable promethazine has been associated with a significant decrease in vomiting compared to earlier flights in which injectable promethazine was not used.

-14-

THE VESTIBULO-OCULAR REFLEX AND OPTOKINETIC NYSTAGMUS UNDER THE INFLUENCE OF CINNARIZINE. I. Doweck, A. Shupak, O. Spitzer, Y. Melamed and C.R. Gordon*. Motion Sickness and Human Performance Laboratory, Israeli Naval Hyperbaric Institute, Haifa, ISRAEL.

INTRODUCTION. Cinnarizine (Cn) is an antihistaminic agent with specific vestibular Ca++ channel blocking capacity, which has been found effective as an anti-motion sickness drug. We used the Vestibulo-ocular reflex (VOR) and the optokinetic nystagmus (OKN) to evaluate Cn's effects on the eye movement control mechanism. METHODS. The VOR parameters were evaluated using the Smooth Harmonic Acceleration Test (SHA) at 5 frequencies: 0.01-0.16 Hz. The OKN was also evaluated using a sinusoidal rotatory pattern at 3 frequencies: 0.01-0.04 Hz. The study was conducted on 16 healthy subjects aged 18-22. The effects of Cn 50 mg vs placebo were compared using a double-blind, randomized, crossover design 2 hours after drug administration. All 16 subjects underwent the SHA test, but only 12 completed the OKN test. RESULTS. Under the influence of Cn 50 mg, VOR gain at 0.04 Hz and phase lead at 0.16 Hz were significantly lower, while on the OKN test, phase lead values were higher at 0.01 Hz. CONCLUSIONS. Cn 50 mg partially affects both VOR and OKN parameters. The drug's influence on the OKN's phase parameter suggests that Cn affects the oculomotor pathways as well as the vestibular end organ.

-15-

MOTION SICKNESS INVESTIGATION: THE CHOICE OF TREATMENT? I.A. Nichiporuk, A.I. Grigoriev. Institute for Biomedical Problems, Moscow, USSR.

INTRODUCTION. In spite of successful treated motion sickness (MS) episodes during space flights, this problem remains actual until its pathogeny will be clear.
METHODS. More than 100 various susceptible to laboratory induced MS male volunteers were examined by electro-physiological and radioimmune assay methods for estimation of central nerve system (CNS) activity and blood concentration of pituitary-adrenal, thyroid, pancreatic, and vasoactive hormones. Some energy metabolism substrates (EMS) were determined in brain structures during MS simulating animal experiments. Various drugs have been used for MS treatment. RESULTS. MS induced reactions expressed stress-associated hormones blood excess followed CNS excitation, and blood EMS increase for its easy delivery to brain structures. All drugs while being effective in MS treatment, significantly decreased CNS activity, accompanied with reduced endocrine and metabolic changes. CONCLUSION. Our data evidence that any effective pharmacological MS treatment probably would result in physical and psychological activity depression which could complicate flight program success. Therefore, no-drug MS countermeasures, or drug-induced adaptive reactions increase would be prefered.

-16-

HEMODYNAMIC MEASUREMENTS DURING PARABOLIC FLIGHT A. Miyamoto*, S. Nagaoka, K. Suzuki, S. Kaneko, S. Watanabe*, S. Usui, J. Nakayama, T. Kojima.
National Space Development Agency of Japan, Nagoya University, Toyohashi University of Technology, Toray Research Center.

INTRODUCTION. A parabolic flight is a useful method as a simulation of weightlessness to study cardiovascular deconditioning, even though the available time is very short.
METHODS. Cardiac output and blood pressure were continuously monitored during parabolic flights performed by a small rear-jet aircraft (MU 300). A male subject, 28 years old, took 9 to 11 parabolic flights a day for 6 days. Two accelerating patterns, 2.5-G and 1.3-G level, were used. Cardiac output was measured by impedance cardiography and blood pressure was measured by a finger pressure cuff method. The positions of the subject were sitting up straight and sitting reclined.
RESULTS. Heart rate increased by 25% at 2.3-G accelerating period and decreased by 10% during low G period in the sitting up position. Stroke volume decreased by 30% at 2.3-G entry and increased by 30% during low G period. These changes became less in the 1.3-G pattern and in the sitting reclined position too. Diastolic blood pressure decreased during low G period. The subject seemed adapted in the latter parabolas in the same day.
CONCLUSION. These results suggested that the hemodynamic changes in the parabolic flight would be modified by the pattern of acceleration and adaptation of the subject.